Lecture at the technical conference of ESCHFOE 2019 in Malmö

Calculation of combustion air supply according EN 13384

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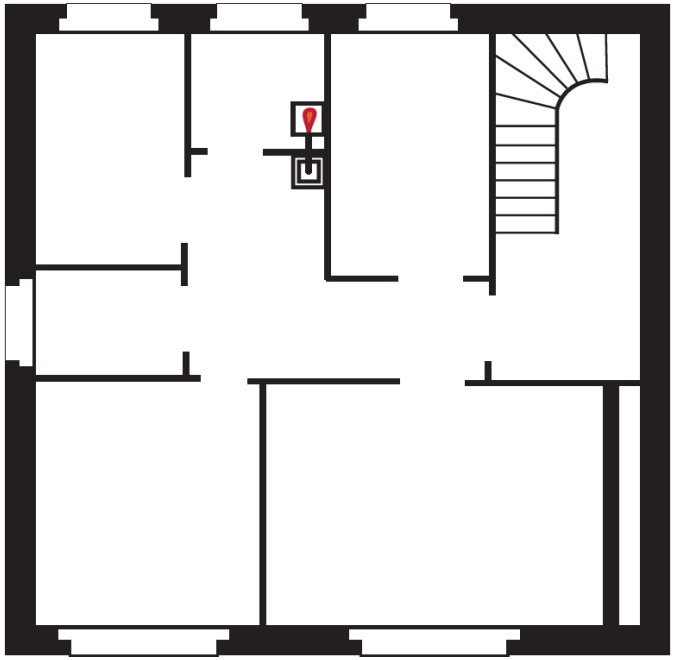
Company

Headquartered in Cologne, Hottgenroth / ETU develops commercial, technical and CAD software as well as Internet applications for chimney sweeping, energy efficiency, construction and ancillary trades and building services. Our customers are chimney sweeps, planners, architects and craftsmen. In some areas, Hottgenroth is the market leader today.

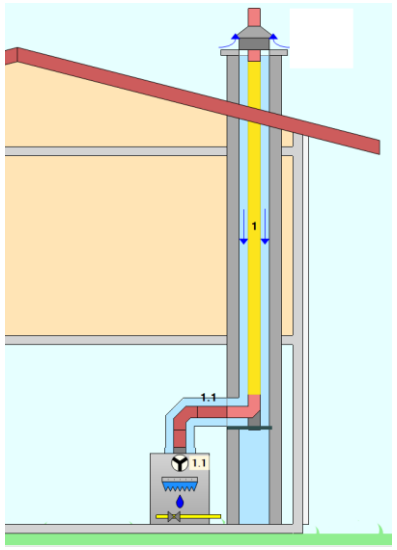
Where does the combustion air come from

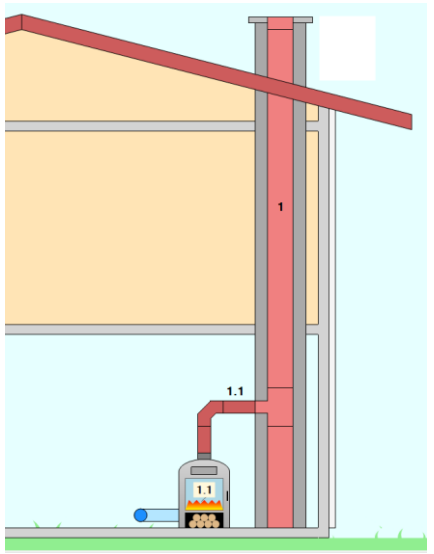
- From the installtion room and the bounding rooms (non room sealed)



- Against the background of good insulation of the building envelope, it could make some problems

- From the outside via pipes or balanced flue chimneys (room sealed operation)





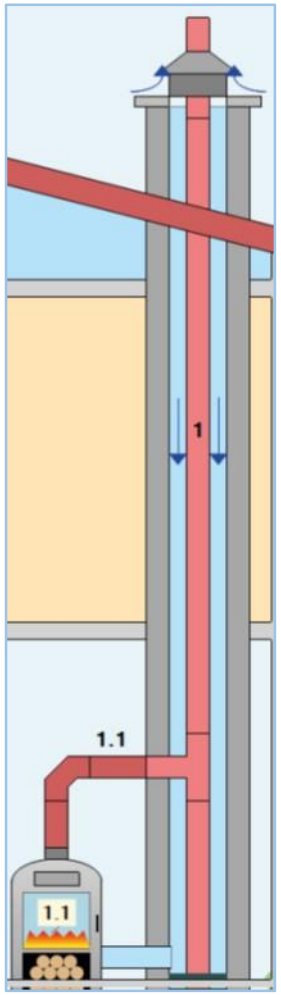
- Indepently from the building envelope
- Combustion appliances need a certificate for room sealed operation

Combustion air supply in the EN 13384 standard

- Non room sealed
  - NO proof of sufficient combustion air
    - Combustion air from the ventilated installation room
    - Combustion air from the installation room and bounding rooms
  - Proof of sufficient combustion air
    - Combustion air from the ventilated installation room, air openings are known
- Room sealed
  - Proof of sufficient combustion air
    - Flue balanced chimney
    - Cumbustion air pipe from the outside to the combustion appliance

Combustion air supply in the EN 13384 standard

- Only possible
  - If the combustion air comes via a pipe or an air opening into the installation room
  - If the combustion air goes directly via pipe to the combustion appliance
- Proof with the pressure requirement
  - Calculation of the pressure resistance of the air supply (P_B)
  - We need for the calculation
    - Cumbustion air mass-flow of the combustian appliance
    - Geometry and data of the cumbustion air pipe (air gap, opening)



Pressure conditions air gap

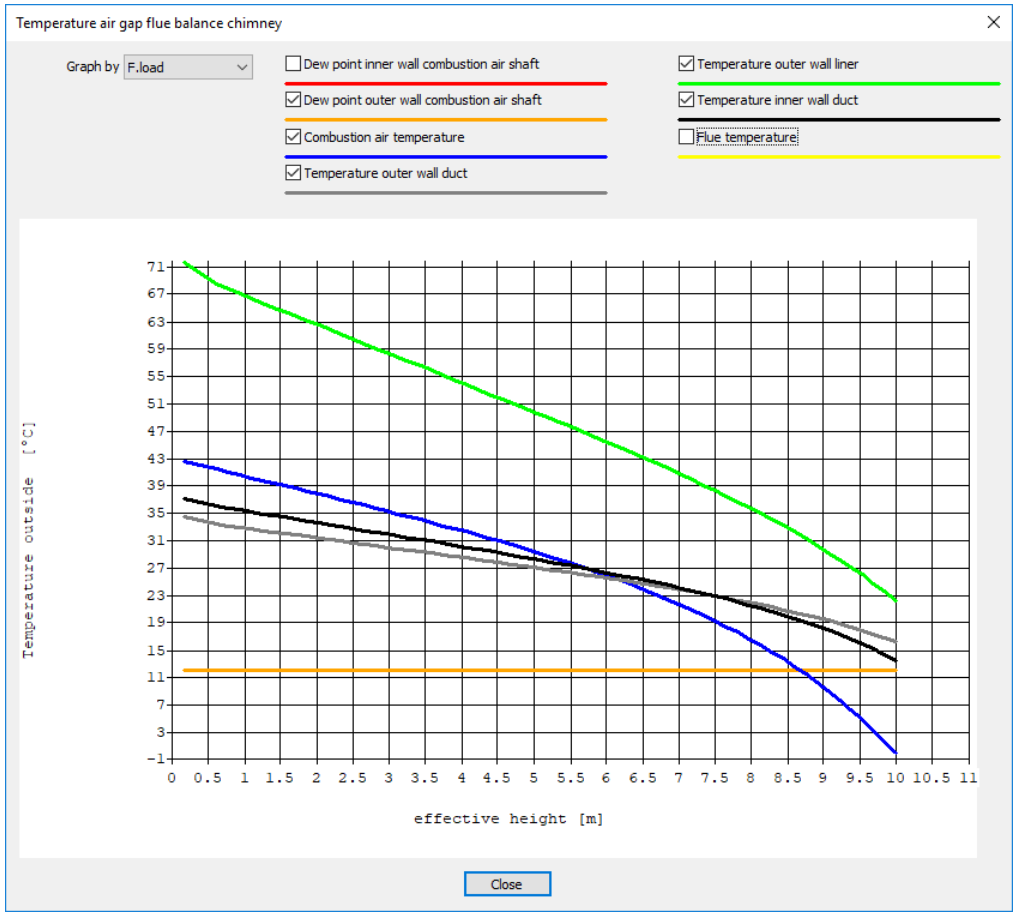
$$P_B = P_{BV} + P_{BS}$$

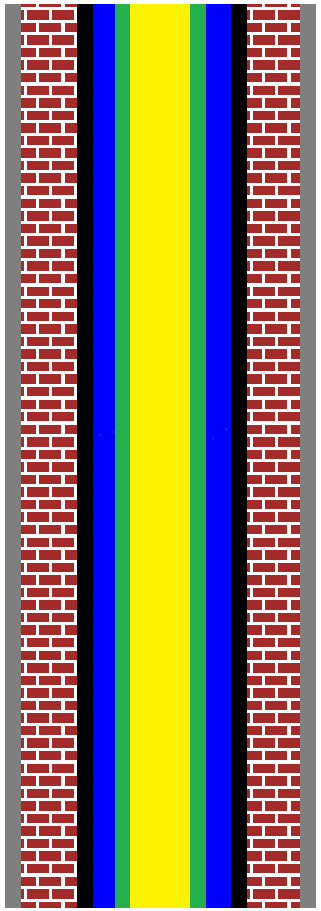
$$P_{BV} = P_{HBV} + P_{RBV}$$

$$P_{BS} = P_{HBS} + P_{RBS}$$

P_B	Pressure resistance of the air supply
P_{HBV}	„Boost“ pressure combustion air, connecting pipe
P_{RBV}	Pressure resistance combustion air, connecting pipe
P_{HBS}	„Boost“ pressure combustion air, vertivcal pipe

Temperature profile flue balanced chimney





Temperatures

- Combustion air
- Outer wall duct/shaft
- Outer wall liner/pipe
- Inner wall duct/shaft
- Flue gas

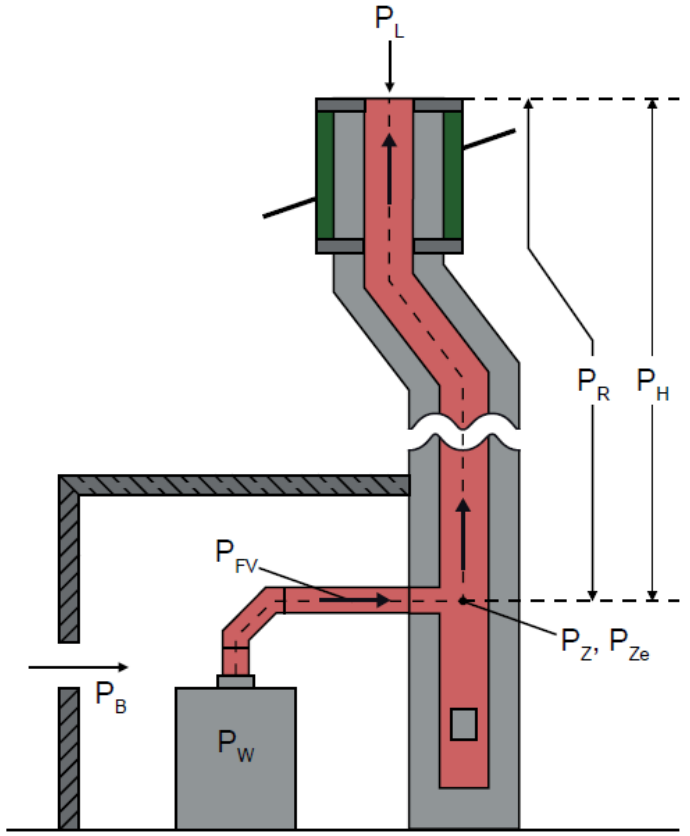
Functional proof pressure requirement

$P_Z \geq P_{ze}$
$P_Z = P_H - P_R - P_L$
$P_{Ze} = P_W + P_{FV} + P_B$

P_{Ze} Required draught at the flue gas inlet to the chimney

P_Z Draught at the flue gas inlet to the chimney

P_B Pressure resistance of the air supply



Functional proof temperature requirement

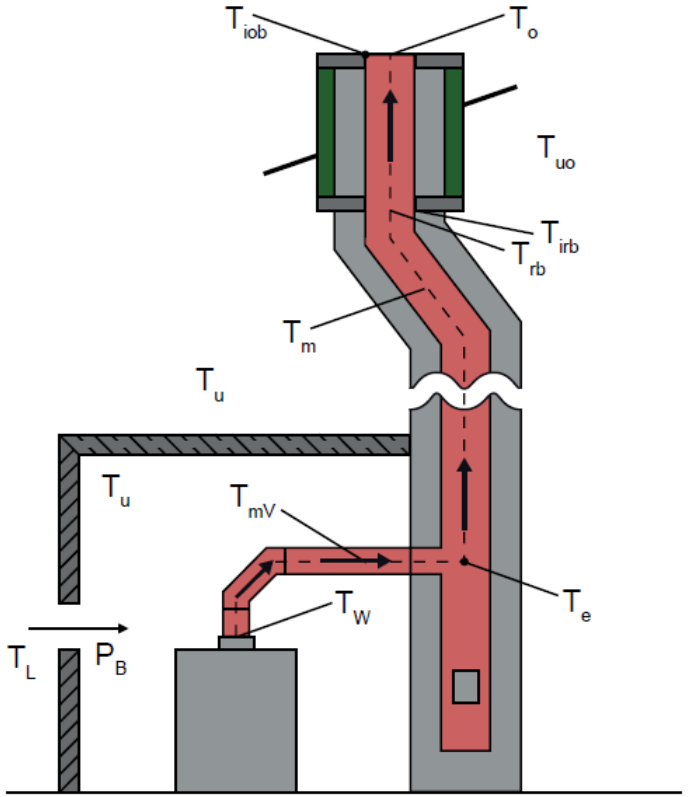
T_g → Dew point temperature	$T_{iob} >= T_g$
T_g → 0°C	$T_{irb} >= T_g$

T_{iob} Temperature of the inner wall of the chimney outlet

T_{irb} Flue gas temperature immediately before the additional insulation

T_g Temperature limit

T_{uo} Ambient air temperature at the chimney outlet



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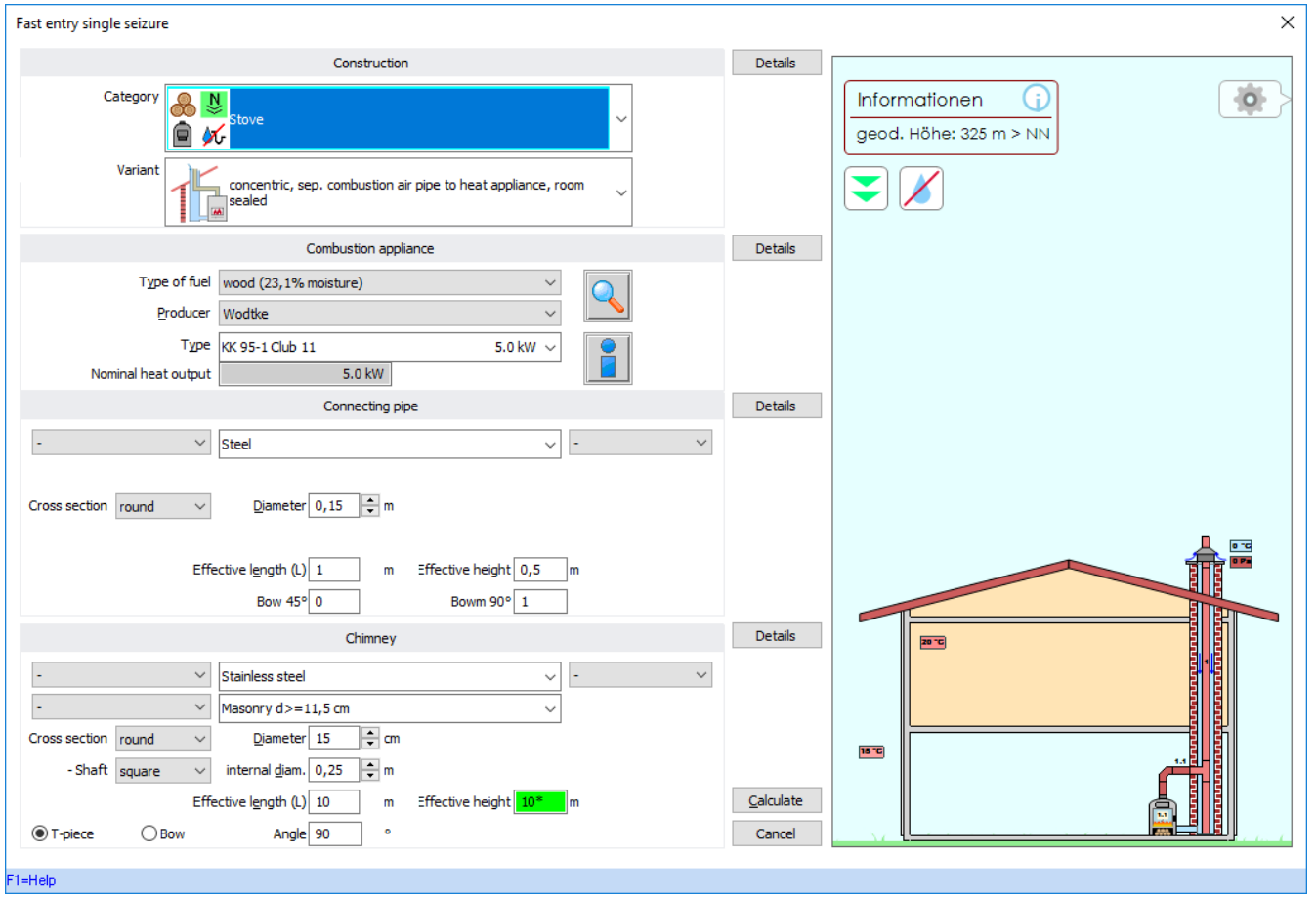
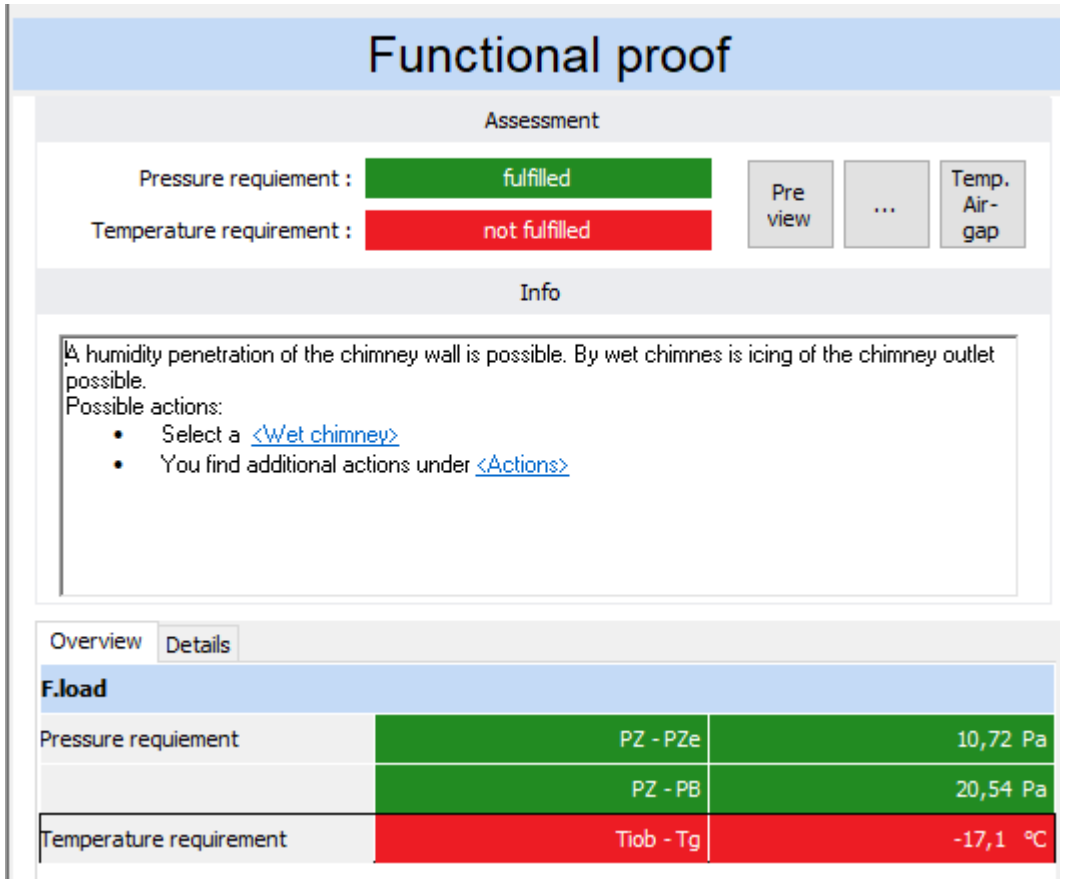
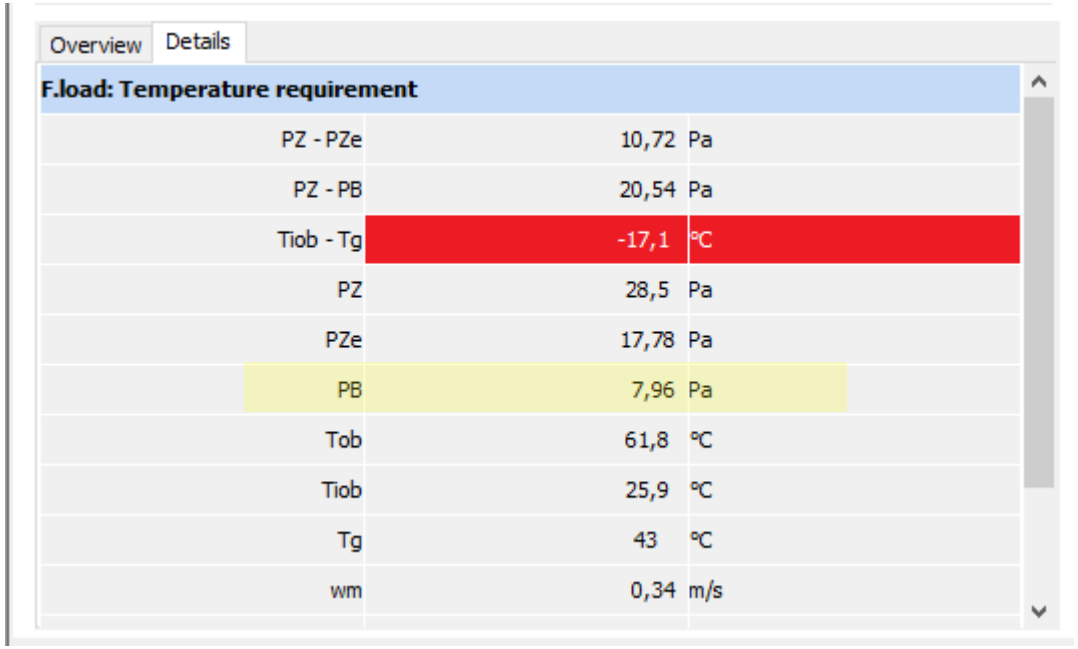
Example calculated with EuroKAM



Results


Functional proof
Assessment
Pressure requiement :
fulfilled
Temperature requirement :
not fulfilled
Pre view
...
Temp. Air-gap
Info
A humidity penetration of the chimney wall is possible. By wet chimnes is icing of the chimney outlet possible.
Possible actions:
Select a <Wet chimney>
You find additional actions under <Actions>
Overview
Details
F.load
Pressure requiement
PZ - PZe
10,72 Pa
PZ - PB
20,54 Pa
Temperature requirement
Tiob - Tg
-17,1 °C


Overview
Details
F.load: Temperature requirement
PZ - PZe 10,72 Pa
PZ - PB 20,54 Pa
Tiob - Tg -17,1 °C
PZ 28,5 Pa
PZe 17,78 Pa
PB 7,96 Pa
Tob 61,8 °C
Tiob 25,9 °C
Tg 43 °C
wm 0,34 m/s

Results with insulated liner

Functional proof

Assessment

Pressure requiement : fulfilled

Temperature requirement : fulfilled

Pre view | ... | Temp. Air-gap

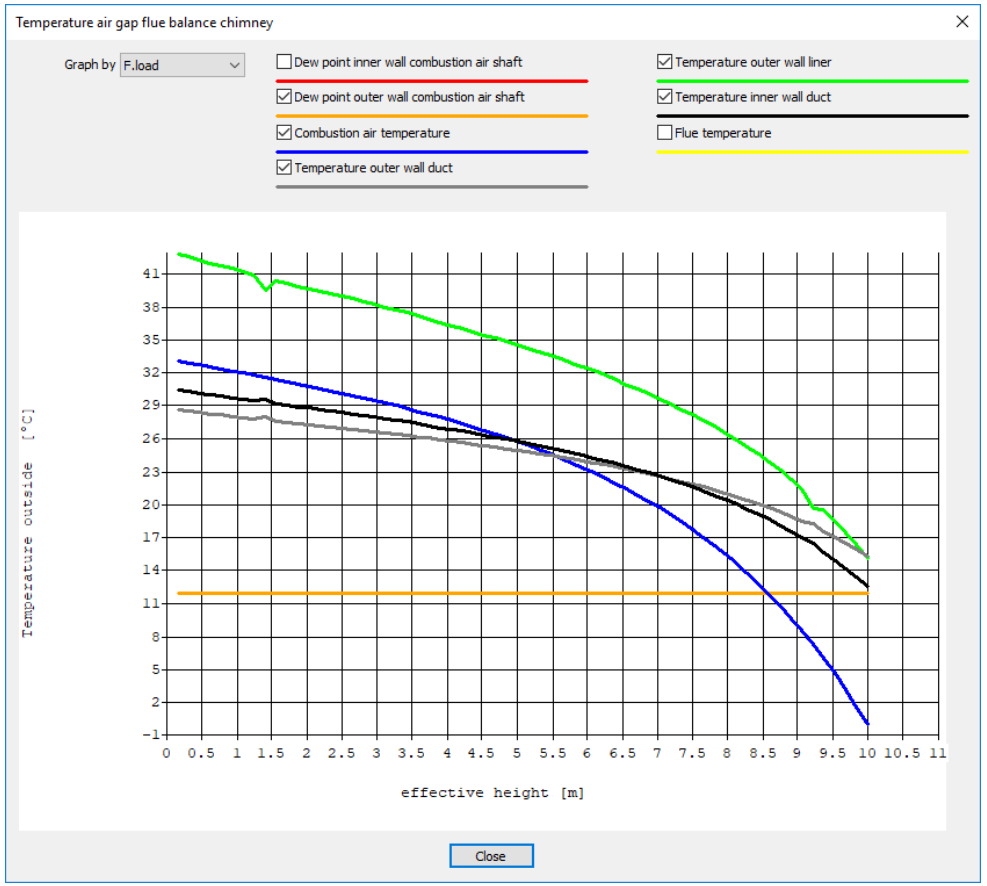
Info

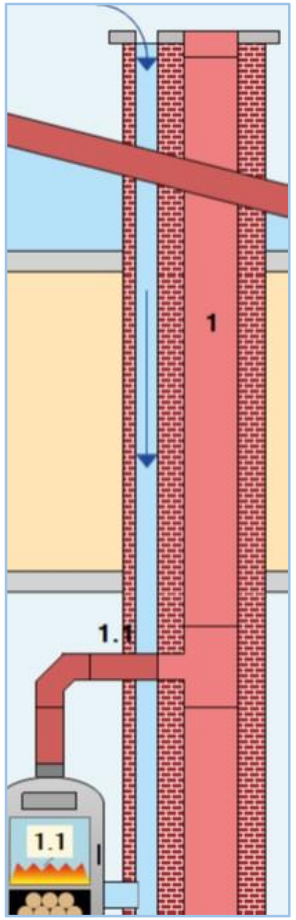
Congratulations!
All requirements of the EN 13384 are fulfilled!

Overview | Details

F.load

Pressure requiement	PZ - PZe	17,29 Pa
	PZ - PB	27,11 Pa
Temperature requirement	Tiob - Tg	24,4 °C





Pressure and temperature conditions separate combustion air shaft

- Pressure conditions like air gap
- TmB: Medium temperatur combustion air
  - Calculation with an approximate equation
  - If thermal resitance is ≥ 0,65 m^2 K/W then $T_{mB}=T_L$

    ➡ „Boost“ of the combustion air $P_{HBS}= 0$
  - In all other cases $T_{mB}= \frac{1}{\frac{0,7}{TL}+\frac{0,3}{Tm}}$

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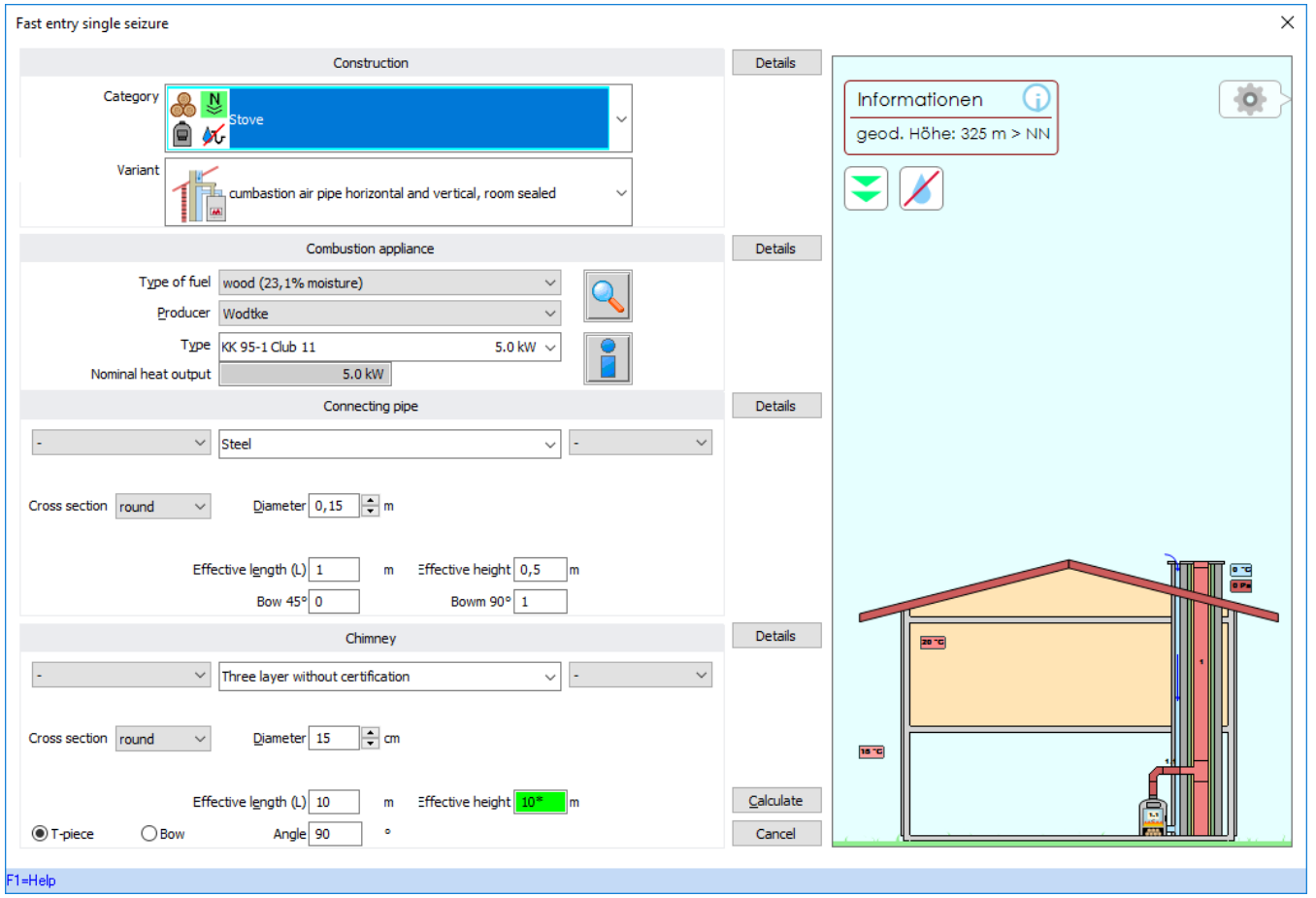
Example calculated with EuroKAM



Results with three layer chimney, with out certification

Functional proof

Assessment

Pressure requiement : fulfilled

Temperature requirement : fulfilled

Pre view

...

Info

Congratulations!
All requirements of the EN 13384 are fulfilled!

Overview | Details

F.load

Pressure requiement	PZ - PZe	3,47 Pa
	PZ - PB	13,29 Pa
Temperature requirement	Tiob - Tg	0,6 °C

Internal values

Flue gas velocity outlet	m/s	0,2922	0,3146
S(ZETA)		1,2000	1,2000
Change of pressure by change of v.	Pa	-0,0164	-0,0137
pressure resistance, friction+ form resistance	Pa		0,2209
Zeta13		0,0000	0,0000
P13	Pa	0,0000	0,0000
Zeta23		0,0000	0,0000
P23	Pa	0,0000	0,0000
Static pressure	Pa	28,0977	38,0280
Resistance pressure	Pa	0,3149	0,3400
- Delivery pressure	Pa	27,7828	37,6880
Sound level	dB	0,0000	0,0000
Combustion air pipe			
Cross section	m²	0,01	
Circumference	m	0,4	
hydraulical diameter	m	0,1	
Combustion air mass flow	kg/s	0,0075	0,0075
Supply air temp.	°C	38,7725	42,6007
Reynolds number		4466,3479	4420,6225
dynamic viscosity	* 1E-6 * Ns/m²	16,7922	16,9659
Friction coefficient of pipe		0,0764	0,0764
mean density	kg/m³	1,0391	1,0265
velocity of flow	m/s	0,7218	0,7307
Zeta13		0,0000	0,0000
P13	Pa	0,0000	0,0000
Zeta23		0,0000	0,0000
P23	Pa	0,0000	0,0000
Static pressure	Pa	8,4096	9,6454
Resistance pressure	Pa	11,8968	13,1770

Results with three layer chimney, with certification

Functional proof

Assessment

Pressure requiement : fulfilled

Temperature requirement : fulfilled

Pre view ...

Info

Congratulations!
All requirements of the EN 13384 are fulfilled!

Overview | Details

F.load

Pressure requiement	PZ - PZe	14,14 Pa
	PZ - PB	23,97 Pa
Temperature requirement	Tiob - Tg	19,4 °C

Internal values

Flue gas velocity outlet	m/s	0,3028	0,3291
S(ZETA)		1,2000	1,2000
Change of pressure by change of v.	Pa	-0,0149	-0,0116
pressure resistance, friction+ form resistance	Pa		0,2279
Zeta13		0,0000	0,0000
P13	Pa	0,0000	0,0000
Zeta23		0,0000	0,0000
P23	Pa	0,0000	0,0000
Static pressure	Pa	30,0971	40,1407
Resistance pressure	Pa	0,3269	0,3548
- Delivery pressure	Pa	29,7702	39,7859
Sound level	dB	0,0000	0,0000
Combustion air pipe			
Cross section	m²	0,01	
Circumference	m	0,4	
hydraulical diameter	m	0,1	
Combustion air mass flow	kg/s	0,0075	0,0075
Supply air temp.	°C	15,0000	15,0000
Reynolds number		4776,9179	4776,9179
dynamic viscosity	* 1E-6 * Ns/m²	15,7005	15,7005
Friction coefficient of pipe		0,0761	0,0761
mean density	kg/m³	1,1248	1,1248
velocity of flow	m/s	0,6668	0,6668
Zeta13		0,0000	0,0000
P13	Pa	0,0000	0,0000
Zeta23		0,0000	0,0000
P23	Pa	0,0000	0,0000
Static pressure	Pa	0,0000	0,0000
Resistance pressure	Pa	3,2124	3,2124

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Many thanks for your attention